

Fig 1: Not in "Presence"

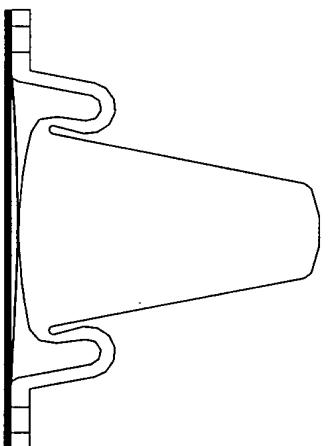


Fig 2: In "Presence"

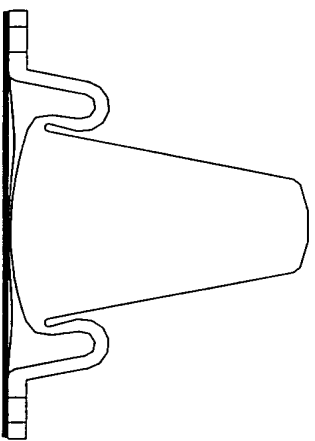


Fig 3: Clicking (Dome Switch collapsed)

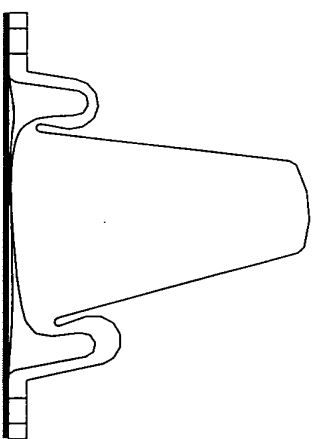
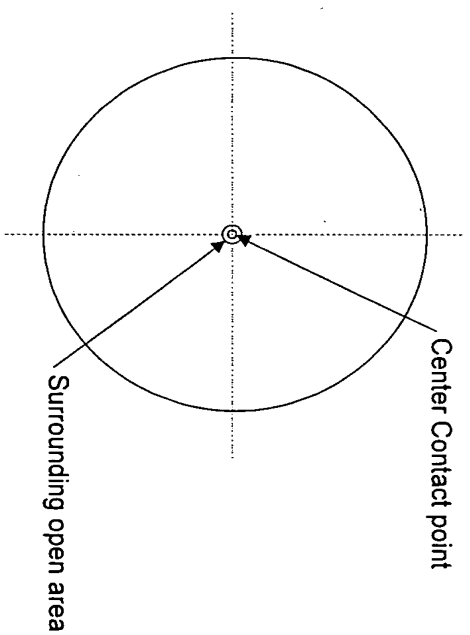
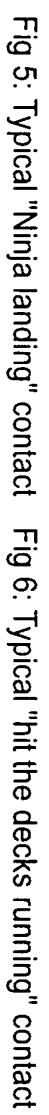
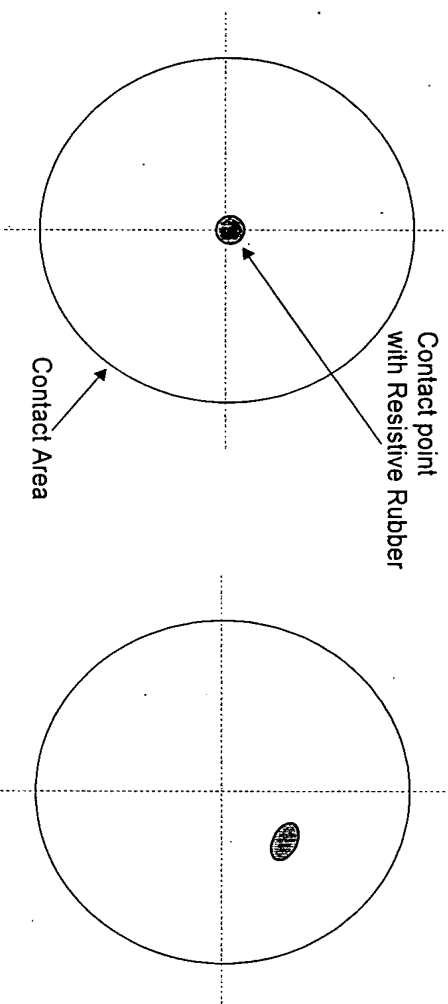


Fig 4: Clicking "On the Fly"



1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348	2349	2350	2351	2352	2353	2354	2355	2356	2357	2358	2359	2360	2361	2362	2363	2364	2365	2366	2367	2368	2369	2370	2371	2372	2373	2374	2375	2376	2377	2378</
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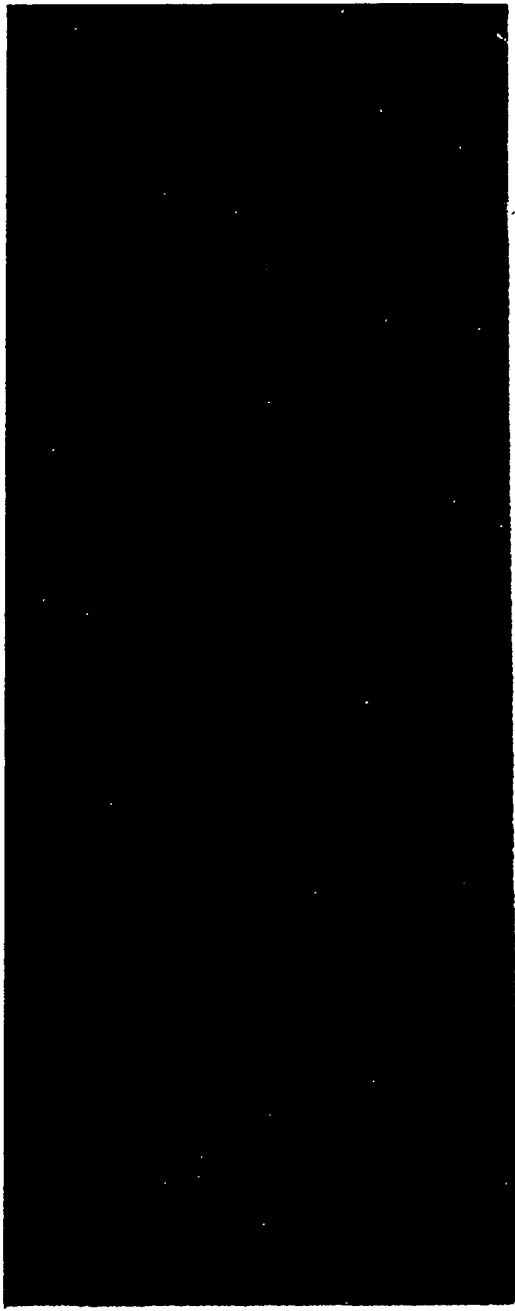
[illegible]

Fig. 8

tions a separate switch is provided, which may be scanned in other code, or by some other processor.

#### c) SNAPTOGRID

This switch determines whether code will be generated to cause motion near a multiple of 90 degrees to “snap” to those directions. This switch is normally turned on when the application involves GUI (Graphical User Interface) menu navigation, etc. It would be less desirable if the primary application involved sketching and drawing.

#### d) NAVIGATEMENU

This switch determines whether code will be generated to cause motion near a multiple of 45 degrees will “snap” to those directions. It is much like the SNAPTOGRID switch, but allows “snapping” to the true axes and the 45-degree diagonals. As with SNAPTOGRID, the intended application would dictate whether this switch should be set.

#### e) AUTOCENTER

This switch determines whether code will be generated to cause the system to re-calibrate itself for “centering”, the position at which no motion is generated. In any joystick or joystick-like pointing device, any of a number of situations can cause the “null” position to be other than where the user expects it. This can cause a perception of “skating in the wind”, or “drift”. This switch would normally be turned on, except perhaps for some unusual applications in which the autocentering behavior conflicts with other design goals. With this switch turned on, the system automatically re-calibrates itself based on a rolling average of contact points, with automatic compensation for outlying values.

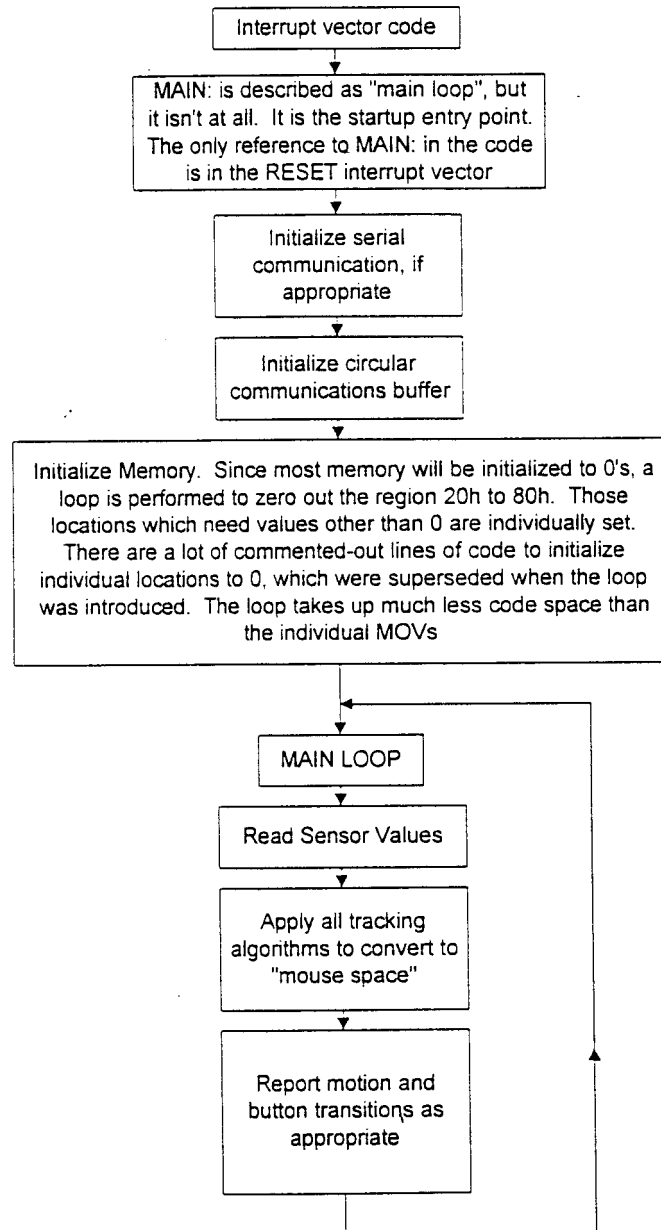


Fig. 9

Microcontroller reads a minimum deflection at a slightly larger than minimum deflection on a nominal Varapoint (this must be the case for a nominal setup so we can always attain a minimum deflection taking variation of component values account). As deflection is increased, the charge time is decreased, since the direction's distance to Vcc is decreased. If the charge time is longer than the 1.397 msec sampling interval, this is read as no deflection at all.

Parameter-based parameters

TblSpeedVect and TblDelayVect tables work together to implement the main part of Varapoint tracking. These tables will normally be adjusted together to account for differences in microprocessor speed and A/D circuits (such as different reference voltages, resistor and capacitor values, etc.). Together, these tables implement a "Three Plateaus" approach to tracking: *Fine Control*, *Navigation*, and *Blitz*. A general strategy for adjusting these tables would be to compare a trial implementation with a reference design Varapoint, and to try to achieve a similar level of control. Fine-tuning would best be accompanied with user-level tests on small subject groups using Varapoint's Pointer Evaluation software, its Fitt's Law suite in particular.

TblSpeedVect

This is the primary tracking table, working in conjunction with TblDelayVect. It contains 32 entries, for each of 32 possible input counts (coming from the A/D circuit). For each input count, it gives the number of output counts ("Mickey") that the firmware should report. These Mickey counts correspond to the counts normally made by optical encoders in a typical 300-dpi mouse. Thus, when the A/D measures a force corresponding to NNN input counts from the A/D, the system will report TblSpeedVect(NNN) Mickey on

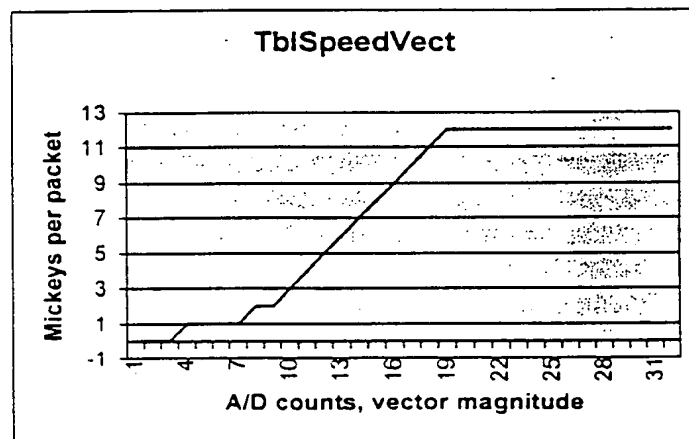


Fig. 10A

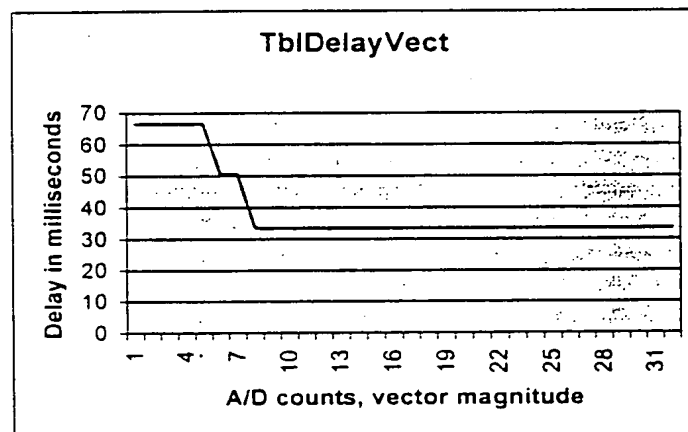


Fig. 10B

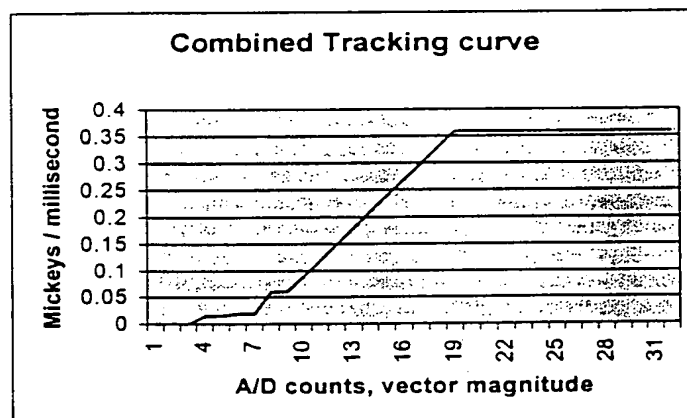


Fig. 10C

report out, which will occur every TblDelayVect(NNNN) milliseconds.

## TblDelayVect

This table works in conjunction with TblSpeedVect to condition the apparent rate of motion reported by the firmware. The TblSpeedVect/TblDelayVect system is an alternative to "Fractional Mickey" tracking, which would have to be maintained if the motion would correspond to less than one Mickey (usually 1/300 of an inch) per packet of data sent out. By delaying the time between packets, the effective rate of motion is kept appropriately low when the intended motion is slow.

## TblSlowVect

This table manages an important aspect of Varapoint tracking – an alternative tracking during deceleration to manage the "overshoot" which so often otherwise characterizes joystick pointing. During tracking, the firmware always remembers the last force vector magnitude, and continually compares to the current force vector magnitude. When the magnitude is decreasing, when the user is attempting to slow down. The difference between last and current magnitude will be positive during deceleration, and is used as an index into the TblSlowVect to calculate an adjustment to the speed to help slow down motion faster and minimize overshoot. The value in the table is multiplied by previous (larger) magnitude, and that number is subtracted from the current magnitude.

## Tracking Algorithm Description

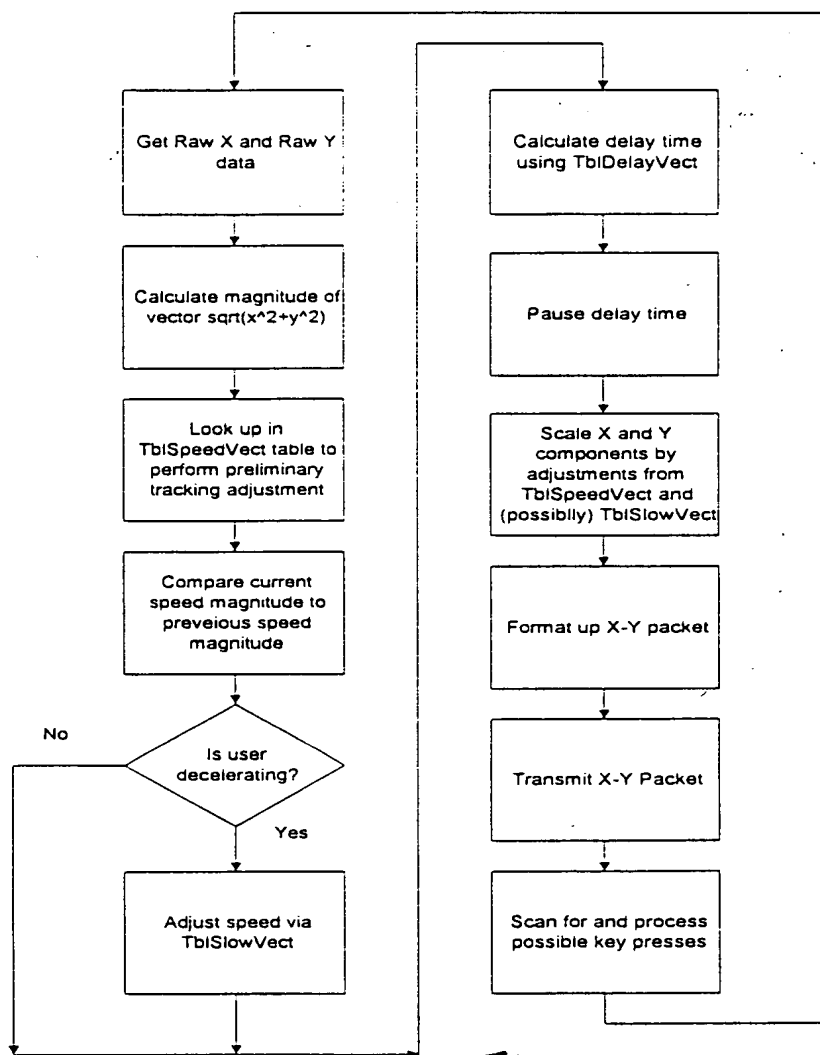


Fig. 11

## System Hardware Requirements